

**IPPT PAN DOCTORAL STUDY  
TEACHING PROGRAMME**

**WARSAW 2013/2014**

---

***Fundamentals of Tensor Calculus***

***Katarzyna Kowalczyk-Gajewska, Ph.D., Dr. Habil., Eng.***

***Department of Mechanics of Materials***

The course contains fundamentals of tensor calculus necessary for the description of problems within continuum mechanics including basic notion of linear algebra, definition of a tensor product and other tensor operations, invariant decompositions of tensors of a second and fourth order, symmetry groups of tensors and tensor functions and elements of tensor analysis.

**Main topics:**

1. Basic notions of linear algebra (e.g.: a group, a linear space, the Euclidean space). Basis of the Euclidean space. Transformation rules.
2. Tensor product and the tensor space of an arbitrary order. Basis of the tensor space and transformation rules for tensors. Tensor operations. Tensor as a linear operator. Automorphisms of a tensor space.
3. Spectral decomposition of a second order tensor. Orthogonal invariants of tensors. The Cayley-Hamilton theorem. Polar decomposition of the second order tensor.
4. Symmetry groups of tensors and tensor functions. Invariant decomposition of the fourth order tensors. Elements of the theory of tensor function representation. Derivatives of tensor functions.
5. Derivative and integral operations for a tensor fields in an affine space. Tensor fields in curvilinear coordinate systems.

**The total number of lecture hours: 30, laboratory exercises: 15 hours, self-teaching: 40, direct tutoring and consultations: 15 hours.**

**ECTS Points: 4**